# SAMPLE GEAR CALCULATIONS AND USE OF "TRIG." TABLES AND INVOLUTE FUNCTIONS

## Gear Data

| | Pinion | Gear |
|---|---|---|
| No. of Teeth (N) | 26 | 78 |
| Normal D.P. (NDP) | 20 | |
| Trans. D.P. (TDP) | 19.8095 | |
| Normal P.A. (NPA) | 20° | |
| Trans. P.A. (TPA) | 20° 10' 36" | |
| Helix Angle (HA) | 7° 55' | |
| Outside Dia. (OD) | 1.4125 | 4.0375 |
| Pitch Dia. (PD) | 1.3125 | 3.9375 |
| Base Dia (B) | 1.2319 | 3.6959 |
| Trans. Cir T.T. (TTT) | | .0763 + .000 - .001 |
| Theo. Center Distance (C) | 2.625 | |
| Actual Center Distance (c) | 2.625 | |
| Lead | 29.6515 | 88.9547 |

Constants: (For both Gear & Pinion)

| TPA = 20° 10' 36" | NPA = 20° | HA = 7° 55' |
|---|---|---|
| Sin .34492 | Sin .34202 | Cos .99047 |
| Cos .93863 | Cos .93969 | Tan .13906 |
| Tan .36747 | Tan .36397 | |
| Inv .015317 | | |

$TCP = \frac{3.1416}{TDP} = .15859$ $NCP = \frac{3.1416}{NDP} = .15708$

TBP = TCP x Cos TPA = .14886 NBP = NCP x Cos NPA = .14760

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## Rolling for size with known Master Gear to check 78T. Gear

(2)

Known:
(TPA 20° 10' 36"
(TCP .15859
Gear (TTT .0763
( N 78

Master Gear has same specs. as above
except ARCT (t) = .0803 N=60

(1) $$2C = \frac{N_{gear} + N_{master\ gear}}{TDP}$$

$$2C = \frac{78 + 60}{19.8095} = 6.9663$$ (Theo. C.D. of 60T. Master & 78 T Gear)

(2) $y = 2c \times \text{Inv TPA} + TTT + t - TCP$

$y = 6.9663 \times .015317 + .0763 + .0803 - .15859$

$y = .10670 + .0763 + .0803 - .15859$

$y = .10471$

(3) $$\text{Inv } a = \frac{y}{2C} = \frac{.10471}{6.9663} = .015030$$

$a = 20°\ 3'\ 15''$

$\text{Cos } a = .939365$

(4) $$c = \frac{C \times \text{Cos TPA}}{\cos a} = \frac{3.48315 \times .93863}{.939365}$$

$$c = \underline{\underline{3.4804}}$$

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Page E Block measurement of gear teeth for 78 T. gear

Known:

TTT = .0763

PD = 3.9375

NPA = 20°

TPA = 20° 10' 36"

B = 3.6959

NBP = .14760

(1) $v = \frac{TTT}{PD} + \text{Inv } TPA$

$v = \frac{.0763}{3.9375} + .015317 = .019377 + .015317$

$v = .034694$

(2) $BTT = B \times v \times \frac{\text{Sin } NPA}{\text{Sin } TPA}$

$BTT = 3.6959 \times .034694 \times \frac{.34202}{.34492}$

$BTT = 3.6959 \times .034694 \times .99159 = .12714$

Span of number of teeth to be measured is approx. $= .5 + N \frac{TPA°}{180°}$

$= .5 + 78 \frac{20.17°}{180°} = 9.24$

(3) Block or span measurement over 9 teeth = BTT + (No. of teeth spanner - 1) NBP
$.12714 + (9-1)\ .14760 = \underline{\underline{1.3079}}$

(4) Double check for contact at, or near PD
PD x Sin TPA = 1.358 (close enough)

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## Page G To find dimension over rolls for 78 T. Gear (External)

Known:-

N = 78
NDP = 20
NPA = 20°
B = 3.6959
TPA = 20° 10' 36"
HA = 7° 55' at PD
TTT = .0763 at PD

(1) NTT = TTT x Cos HA
NTT = .0763 x .99047 = .07557

(2) $$\text{Inv } e = \text{Inv TPA} + \frac{\text{NDP}\,(w \times \text{Sec NPA} + \text{NTT}) - 3.1416}{N}$$

Let $w = \frac{1.728}{\text{NDP}}$ $w = .0864$

$$\text{Inv } e = .015317 + \frac{20(.0864 \times 1.0642 + .07557) - 3.1416}{78}$$

$$\text{Inv } e = .015317 + \frac{3.35032 - 3.1416}{78}$$

$$\text{Inv } e = .015317 + .002675 = .017992$$

e = 21° 14' 55" Sin e = .36242 Cos e = .93202

(3) For even teeth - $M = \frac{B}{\text{Cos } e}$

$$M = \frac{3.6959}{.93202} = 3.9655$$

(4) For externals - E = M+ w
E = 3.9655 + .0864 = $\underline{\underline{4.0519}}$

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For calculating dimension over rolls
For .0753 TTT use "K" factor

$$K = \frac{\text{Cos TPA}}{\text{Sin e}} = \frac{.93863}{.36242} = 2.59$$

(1) $\Delta E = \Delta t_{trans} \times K$

$\Delta t$ trans = .0763 - .0753 = .0010

$\Delta E = .001 \times 2.59 = .0026$

(2) $E_{.0753} = E_{.0763} - .0026$

$E_{.0753} = 4.0519 - .0026 = \underline{\underline{4.0493}}$

Page I Contact ratio or tooth overlap

Known:

| | Pinion #1 | Gear #2 |
|---|---|---|
| Base radius $b_1$ = | .61595 | $b_2$ = 1.84795 |
| Pitch radius $p_1$ = | .65625 | $p_2$ = 1.96875 |
| Outside radius $d_1$ | .70625 | $d_2$ = 2.01875 |
| C = 2.625<br>HA = 7° 55' | TBP = .14886 | TCP = .15895 |

(1) $\text{Cos } M_1 = \frac{.61595}{.70625} = .87214$ $\text{Cos } M_2 = \frac{1.84795}{2.01875} = .91539$

$M_1 = 29°17'30''$ $\text{Sin } M_1 = .48926$ $M_2 = 23°44'20''$

$\text{Sin } M_2 = .40257$

(2) $Zd_1 = .70625 \times .48926 = .34554$ $Zd_2 = 2.01875 \times .40257 = .81268$

(3) $\text{Cos OPA} = \frac{b1 + b_2}{c} = \frac{.61595 + 1.84795}{2.625} = .93863$

OPA = TPA = 20° 10' 36"

(4) ZL = c x Sin OPA = 2.625 x .34492 = .90541

(5) $\text{Contact ratio} = \frac{Zd_1 + Zd_2 - ZL}{TBP}$

Contact ratio (Involute) $= \frac{.34554 + .81268 - .90541}{.14886} = 1.70$

(6) Contact ratio (Face) $= \frac{\text{Face width} \times \text{Tan HA}}{TCP}$

Face width - .500

Contact ratio (Face) $= \frac{.500 \times .13906}{.158} = 0.44$

Helical Gear Only ________

(7) Total contact ratio - Contact ratio (Involute) + Contact Ratio (face) = 2.14

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Page I Involute profile control, scale readings, and degrees of roll

Known: Use data from sheet #6

Z = Length of line of action to point indicated
S = Scale reading on involute machine
°Roll = Roll angle

For Gear #2 - 78 teeth

$Z_{a_2}$ = ZL - Zd, = .90541 - .34554 = .55987

$Z_{P_2}$ = $P_2$ x Sin OPA = 1.96875 x .34492 = .67906

$Z_{d_2}$ = .81268 (from sheet #6 (1) )

Scale reading = 20 x Z

$S_{a_2}$ = 20 x .55987 = 11.20 scales

$S_{P_2}$ = 20 x .67906 - 13.58 scales

$S_{d_2}$ = 20 x .81268 = 16.25 scales

°Roll from Z values

$$°\text{Roll} = \frac{57.2958 \times Z}{b}$$

$$°\text{Roll}_{a_2} = \frac{57.2958 \times .55987}{1.84795} = 17.35°$$

$$°\text{Roll}_{P_2} = \frac{57.2958 \times .67906}{1.84795} = 21.05°$$

$$°\text{Roll}_{d_2} = \frac{57.2958 \times .81268}{1.84795} = 25.20°$$

Also conversion of scale readings to °Roll, etc.

$$°\text{Roll} = 2.8648 \times \frac{S}{b}$$

$$S = .34906 \times b \times °\text{Roll}$$